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AUTHOR Perreault, Gerri
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ABSTRACT

Modern physics and feminism are two seemingly disparate areas of human endeavor that pose important alternatives to and transformations of contemporary world views. Modern physics is a radical shift from the world view of classical physics, and feminism is a radical shift from the world view of patriarchy. Both emphasize interrelatedness and interconnectedness, wholeness and oneness, inseparability of observer and observed, transcendence of the either-or dichotomy, dynamic and organic processes, and the relativity of time. Congruence with these changes in world view calls for a number of changes in higher education, including an emphasis on the interconnectedness and interdependence of people and the planet, a linking of education to experience, an interdisciplinary context, a perspective of both students and knowledge as continually evolving, a balance of rational and intuitive ways of knowing, and recognition of the inseparability of knower and known. (Author)

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FUTURISTIC WORLD VIEWS: MODERN PHYSICS AND FEMINISM
IMPLICATIONS FOR TEACHING/LEARNING IN HIGHER EDUCATION

Paper presented at the Second Annual Conference of
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By:

Gerri Perreault
3224 Harriet Avenue South
Minneapolis, MN 55408
(612) 823-7516

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Gerri Perreault
3224 Harriet Avenue South
Minneapolis, MN 55408
(612) 823-7516

FUTURISTIC WORLD VIEWS: MODERN PHYSICS AND FEMINISM
IMPLICATIONS FOR TEACHING/LEARNING IN HIGHER EDUCATION

(Presented at conference of The World Future Society--Education Section, October 18, 1979, Leamington Hotel, Minneapolis.)

Abstract: Modern physics and Feminism, two seemingly disparate areas of human endeavor, are futuristic world views that pose important alternatives to and transformations of contemporary world views. Modern physics is a radical shift from the world view of classical physics, and Feminism is a radical shift from the world view of patriarchy. Both modern physics and Feminism emphasize interrelatedness and interconnectedness, wholeness and oneness, inseparability of observer and observed, transcendence of the either-or dichotomy, dynamic and organic processes, and the relativity of time.

Congruence with these changes in world view would mean a number of changes in higher education, including an emphasis on the interconnectedness and interdependence of people and the planet, a linking of education to experience, an interdisciplinary context, a perspective on both students and knowledge as continually evolving, a balance of rational and intuitive ways of knowing, and recognition of the inseparability of knower and known.

INTRODUCTION

This paper is titled, "Futuristic World Views: Modern physics and Feminism." But what is a "world view" and what is a "futuristic" world view? And what does modern physics and Feminism, two seemingly disparate areas of human endeavor, one a science and one a social movement, have to do with world views? Is the title merely one to link interests of mine to a conference concerned about the future or is the title central to the point of view being expressed? It is, of course, the latter.

What is a "world view"? World view as used in this paper includes one's values, beliefs, attitudes, and basic assumptions about knowledge and the nature of reality. Anthropologist Anthony Wallace calls world view a "mazeway"--nature, society, culture, personality, and body images as seen by one person (1956:254). It is differentiated from "theory" in that it is broader and

WORLD VIEWS COMPARED

Classical Physics

1. Mind & matter separate
2. Building blocks
3. Independent parts
4. Static & mechanistic
5. Either-or thinking
6. Scientist separate from material world. Objectivity possible.
7. Space & time: absolute

Modern Physics

1. Mind & matter connected
2. Connections
3. Wholeness & oneness
4. Dynamic
5. Transcendence of either-or thinking
6. Scientist inseparable from material world. Objectivity a myth. "Participator."
7. Space & time: relative

Patriarchy

1. Separations & divisions
2. Parts
3. Fragmentation & independent parts
4. Static & mechanistic
5. Either-or thinking
6. Observer separate from world. Objectivity possible.
7. Time absolute

Feminism

1. Lack of separations; interrelatedness
2. Connections
3. Wholeness & oneness
4. Dynamic & organic
5. Transcendence of either-or thinking
6. Observer inseparable from world. Objectivity a myth.
7. Time relative. Illusion of linearity.

includes both explicit and implicit assumptions and beliefs.

What is a "futuristic" world view? It is a world view that poses important alternatives to and/or transformations of (as opposed to mere changes in) present world views. A futuristic world view is one that is not dominant currently but is held by a minority of thinkers and presents significant challenges to current assumptions, beliefs, and values.

The world views which are the focus of this paper are those of physics and Feminism. The paper will describe and compare the similar differences in world views between classical physics and modern physics and between patriarchy and Feminism (see chart, p. 2) and will point out the similarities in the world views of classical physics and patriarchy and of modern physics and Feminism. (Note, though, that the context for the discussion of patriarchy and Feminism is limited to America.) In brief, my thesis is that the world view of classical physics and of patriarchy puts a premium on:

1. Separation, division, categorization
2. Independence, unrelatedness, unconnectedness
3. Isolated and independent parts
4. Static and mechanistic processes
5. Either-or thinking
6. Separation of observer from the world.
Objectivity possible.
7. Absoluteness of space and time

In contrast, modern physics and Feminism are strikingly similar in their emphasis on:

1. Lack of separations and divisions
2. Interrelatedness, interconnectedness
3. Wholeness and oneness
4. Dynamic and organic processes
5. Transcendence of either-or thinking
6. Inseparability of observer and observed.
Objectivity a myth. "Participator" more accurate.
7. Relativity of time and space

It is my assumption and belief that the dominant world view of American society¹ is more closely aligned with the assumptions and beliefs of Newtonian

physics and patriarchy than with modern physics and Feminism, and that although these assumptions have facilitated material "progress" they have also resulted in disastrous consequences for the entire planet.²

Let me illustrate. There are a number of critical, life-threatening problems faced by society and the planet. These include fragmentation and alienation of people, community, and nation; unbridled specialization and technology; destruction of the ecosphere; the reign of technique at the expense of care, compassion, and wisdom; the reign of the various isms (racism, sexism, militarism, etc.) and their consequent life-destroying and limiting oppressions; and a focus on ends rather than means and processes.

The world view common to all of these problems and crises is an assumption, mostly implicit, of separableness, independent and isolatable parts, divisions and differences, and unconnectedness. Modern physics and Feminism both present alternatives to and transformations of these dominant assumptions, assumptions which not only create the problems listed but lead to inadequate solutions.

The problems listed above are not amenable to mere band-aid solutions (e.g., more psychological services to help people cope) and techniques (e.g., more sophisticated computer systems), necessary though some of these may be. Rather, the problems call for a fundamental shift in world view to one that emphasizes wholeness (of the person and of the planet/universe); interrelatedness; transcendence of dichotomies such as rational/intuitive and subjective/objective; interdependence; and attention to process. These characteristics comprise both modern physics and Feminism.

A question may have arisen in the listener's mind by now as to whether or not I am arguing a causal link between the two shifts in world views being discussed. What I am doing is describing what I see as two shifts that seem to be taking place, and I have not attempted to analyze the possible intricate and intrinsic ways in which they might be interconnected. My assumption is that there is some link, perhaps imbedded in what Art Harkins would call "cultural conditions,"³ (part of which, of course, includes physics and Feminism). The futuristic world views described in this paper are probably part of, and contribute to, a larger shift in world views occurring in other areas of the culture as a whole, for example, ecology, some branches of

psychology, and futures study. The probabilistic (as distinct from "exact") nature of the interconnections among all these areas is a task not attempted in this paper.

The discussion of both modern physics and Feminism which follows is of course a linear and rational ("rational" in its root sense meaning "to divide") discussion of multi-dimensional, interrelated, and non-linear and non-rational⁴ topics, and hence carries all the problems co-existent with this contradiction. Capra, a physicist, says:

...the exploration of the subatomic world has revealed a reality which repeatedly transcends language and reason....

--Capra, Tao of Physics, 1975:149

Morgan, a Feminist, says that we must:

...go beyond what we sense (I am assuming that we already are beyond what we know) and test our perceptions of reality. We must admit the entire cosmos as the ground on which such a search takes place. We must recognize the dissolution of the illusion of linear form....

--Morgan, Going Too Far, 1977:290

But I am using language, a linear and rational form, and categories--even more linear and rational--to communicate. The effort has, for me, been worthwhile, and I hope, by the end of the paper, for you too.

The organization of the discussion which follows is first, a description of the paradigm shift from classical physics to modern physics; second, a description of the paradigm shift from patriarchy to Feminism, and, third, implications for teaching/learning in colleges and universities.

PARADIGM SHIFT FROM CLASSICAL PHYSICS TO MODERN PHYSICS

The shift from classical (i.e., Newtonian physics) to modern physics (i.e., Einstein's relativity theory and Planck's quantum theory)⁵ was a paradigm shift in world view. Classical physics is best represented by the analogy of the machine. The key characteristics of this mechanistic universe are:

1. Separation of mind and matter
2. Atoms as building blocks of the world
3. Independent parts
4. Static and mechanistic processes
5. Either-or categories
6. Scientist separate from material world
Objectivity possible
7. Absoluteness of space and time

In contrast, modern physics is best represented by the analogy of an organism. The key characteristics of this organic universe are:

1. Inseparability of mind and matter
2. Patterns of connections rather than building blocks
3. Wholeness and oneness
4. Dynamic and organic processes
5. Either-or categories transcended
6. Scientist inseparable from material world
Objectivity a myth. "Participator" more accurate.
7. Relativity of space and time

The above seven characteristics of classical physics and modern physics will now be described in more detail.

1. Mind and Matter: Separate or Connected

Classical physics is based on a belief in the dualism of mind and matter, or spirit and matter. This belief can be traced to the philosophy of the Greek atomists who saw matter as being made of building blocks called atoms and these atoms were "purely passive and intrinsically dead," moved by some external force assumed to be fundamentally different from matter (Capra 1977:22).

This dualism became part of the thinking of Descartes, a 17th century philosopher who based his view of nature on "its fundamental division into two separate and independent realms, that of mind ("res cogitans") and that of matter ("res extensa")" (Capra 1975:22). This Cartesian conception of matter as dead and completely separate from us was the basis for Newton's mechanistic view of the universe. Nature was assumed to operate

like a machine with cause and effect and was governed by exact and absolute laws which existed in an external world.

In modern physics, mind and matter are not separate. At the subatomic level, mass is nothing but a form of energy (Capra 1975:63, 202), and mass and energy change unceasingly into each other (Zukav 1979). And we ourselves are somehow included--Postle comments that:

...we are energy, that our structure is formed of energy itself acting in the fields of force across space. The only difference between this book and that body of yours is how the energy is organized.

--Postle, The Fabric of the Universe, 1976:80

2. Building Blocks or Patterns of Connections

In Newton's mechanistic model, atoms--solid, material bodies--are the building blocks of the universe. But while this conception is workable in the macroscopic world, it doesn't work in the subatomic realm.⁶

In quantum physics, the idea of atoms and subatomic particles as solid objects is abandoned. The world consists not of things but of interactions and interconnections.

At the subatomic level, units of matter are "abstract entities" which do not exist with certainty at definite places, but rather show "tendencies to exist" (Capra 1977:22, 1975:68, Zukav 1979:57). These "tendencies to exist" are expressed as probabilities, and the corresponding mathematical quantities of these probabilities take the form of waves⁷ (Capra 1977:22). These wave-like patterns of probabilities are not probabilities of things but of interconnections (Capra 1975:68). Any observed "object" is an "intermediate system" (Capra 1976). As Capra explains, subatomic particles "can only be understood as interconnections between the preparation of an experiment and the subsequent measurement," and these relations always include the observer (Capra 1975:68).

3. Wholeness and Oneness

Classical physics saw the universe composed of material, isolatable parts. In modern physics, "reality" is an inseparable, harmonious whole, and separation is an illusion. Rather than the world being a collection

of independent parts or building blocks isolated from one another, it is a "complicated web of relations between the various parts of a unified whole" (Capra 1976:23). As Bohm says,⁸

One is led to the new notion of unbroken wholeness which denies the classical idea of analyzability of the world into separately and independent existing parts....

--Bohm, 1975
(quoted in Capra 1975:138)

And Heisenberg:

The world thus appears as a complicated tissue of events, in which connections of different kinds alternate or overlap or combine and thereby determine the texture of the whole.

--Heisenberg, Physics and Philosophy, 1958

The whole is more than the sum of its parts. The structure of a hadron, for example, "is not understood as a definite arrangement of constituent parts, but is determined by all sets of particles which may interact with one another to form the hadron under consideration" (Capra 1976). Each hadron is understood "as an integral part of an inseparable network of reactions. The emphasis is not on static fundamental structures or entities, but on change and transformation" (Capra 1976).

4. Static or Dynamic

In classical physics, matter was viewed as inert and passive. Indeed it looks that way at the macroscopic level. At the subatomic level, however, "the material that the physicist works with now is change. Events. Interactions. Processes." (Postle 1976:151)

In quantum mechanics, physicists have to take into account the unification of space and time and hence view the particles in terms of activity and processes (Capra 1976).⁹ (See also discussion of the hadron in #3 above.) Particles are seen as bundles of energy, and "energy is associated with activity, with processes, and this implies that the nature of subatomic particles is intrinsically dynamic" (Capra 1976). Matter is "never quiescent but always in a state of motion" (Capra 1977:23). The picture is one of continuous dancing and vibrating motion (Capra 1977). As Capra so beautifully describes it, the interactions:

...involve a ceaseless flow of energy manifesting itself as the exchange of particles; a dynamic interplay in which particles are created and destroyed without end in a continual variation of energy patterns.

--Capra, Tao of Physics, 1975

5. Transcendence of Either-Or Categories

The foundation of quantum mechanics demonstrates the falsity and inadequacy of dividing reality into categories of either-or. The wave-particle duality is a good illustration. At the subatomic level, particles are seen as "tendencies to exist" and these are

...very abstract entities which have a dual aspect. Depending on how we look at them, they appear sometimes as particles, sometimes as waves, and this dual nature is also exhibited by light which can take the form of electromagnetic waves or of particles.

--Capra, Tao of Physics, 1975:67

As Capra remarks,

...the unification of concepts which had hitherto seemed opposite and irreconcilable turn out to be one of the most startling features of this new reality.

--Capra, Tao of Physics, 1975:149

Matter is both continuous and discontinuous, force and matter are different aspects of the same phenomena, space and time are unified, and particles are waves and waves are particles (Capra 1975:149-150).

6. Scientist and Material World: Separate or Inseparable (or Observer and Observed: Separate or Inseparable)

Newtonian physics rests on the assumption of an external world which exists separate from us (Zukav 1979:54) and thus it forms the basis for the concept of scientific objectivity (Zukav 1979:55). It further assumes we can observe, measure, and speculate about the external world without changing it (Zukav 1979:55). In this world of reality, people can be said to discover, rather than create (Rychlak 1968:115).

In quantum mechanics, the "observer" becomes the "participator" (Wheeler n.d.). There is no such thing as objectivity; we cannot eliminate ourselves from the picture (Zukav 1979:56). A person does not discover the facts of nature so much as she or he applies "theoretical systems or

paradigms to it" (Rychlak 1968:115), that is, creates reality.

As Zukav points out, "what we experience is not external reality, but our interaction with it" (1979:115). As noted earlier, the properties of an "object" cannot be defined independently of the processes of preparation and measurement; if the preparation or measurement is modified, the properties of the observed object change (Capra 1976). For example, the apparently mutually exclusive wave-like and particle-like behaviors of light are not properties of light but "properties of our interaction with light" (Zukav 1979:115). The properties described belong to the interaction, "not to independently existing things like light" (Zukav 1979:118). In Heisenberg's words,

What we observe is not nature itself, but nature
exposed to our method of questioning.

--Heisenberg, Physics and Philosophy

7. Space and Time: Absolute or Relative

In classical physics, space was three-dimensional and time was one-dimensional, linear, and separate from space. According to Einstein, however, space and time are inseparably linked; there is no such thing as space and time, only space-time which is a continuum (Zukav 1979:170). There is no universal flow of time from past to present to future.

The theory of relativity "emphasizes the notion that no matter what we observe, we always do so relative to a frame of reference that may differ from someone else's, that we must compare our frame of reference in order to get meaningful measurements and results about the events we observe" (Bentov 1977:3).

In sum, the theory and research of modern physics provides the basis for a world view dramatically different from that of classical (Newtonian) physics. Whereas the latter envisioned a mechanical world, a world of objects, of separations and discrete units, and offered the machine as the model for the universe, the modern physicist envisions a dynamic world, a world of interrelatedness, of oneness, and of change, and a model of the universe as a dynamic, organic one in process.

PARADIGM SHIFT FROM PATRIARCHY TO FEMINISM

Turning now to patriarchy and Feminism, one can see in the shift from a patriarchal world view to a Feminist one a change strikingly similar to the one between classical physics and modern physics (see chart, p. 2). The key characteristics of the patriarchal world view are:

1. Separations and divisions
2. Parts
3. Fragmentation and independent parts
4. Static and mechanistic
5. Either-or categories
6. Observer separate from world
Objectivity possible
7. Time absolute

The key characteristics of the Feminist world view are:

1. Lack of separations; interrelatedness
2. Connections
3. Wholeness and oneness
4. Dynamic and organic
5. Transcendence of either-or categories
6. Observer inseparable from world
Objectivity a myth
7. Time relative

In case the use of the categories, patriarchy and Feminism, are confusing, it might be helpful to distinguish the usage in this paper from more popular connotations. Patriarchy in the popular use of the term usually refers to rule by ^{one sex,} the patriarch, the father, the male, and the consequent biases and institutionalized discrimination against women. Feminism in popular usage usually refers to efforts to counteract this dominant rule of the patriarch, the male, and to construct a more egalitarian society (see definitions, p. 22-23).

In this paper, however, patriarchy and Feminism are being discussed in a broader context as world views and not restricted to a concern with stereotypic biases and institutionalized discrimination related specifically to women and men. Patriarchy here, for example, refers not only to rule by one

sex, the male, but to its world view, its basic assumptions about the world. Feminism as used in this paper refers not only to attempts to counteract patriarchy and to achieve legal and political equality but to its world view, its fundamental assumptions about the world. It should be noted that there are, of course, differences among Feminists, and the Feminist world view discussed here is not one shared by all Feminists. It is one which goes beyond what is called "reformist Feminism", i.e. working toward equality with men (e.g., adding women to the faculty and to high political office) and asks for changes more fundamental than the equality of women with men.

It may be useful to look at David Bakan's (1966) description of the modalities of "agency and communion" since these are to some extent similar to characteristics of patriarchy and Feminism,¹⁰ and somewhat poetically captures the difference between the two. To quote Bakan:

Agency manifests itself in self-protection, self-assertion, and self-expansion; communion manifests itself in the sense of being at one with other organisms. Agency manifests itself in the formation of separations; communion in the lack of separations. Agency manifests itself in isolation, alienation, and aloneness; communion in contact, openness, and union. Agency manifests itself in the urge to master; communion in noncontractual cooperation. Agency manifests itself in the repression of thought, feeling, and impulse; communion in the lack or removal of repression.

Bakan goes on to say:

One of the fundamental points which I attempt to make is that the very split of agency from communion, which is a separation, arises from the agency feature itself; and that it represses the communion from which it has separated itself.

Patriarchy would be aligned with the world view underlying agency in that patriarchy emphasizes separation, division, categorization, fragmentation, independence, prediction and control (mastery), and the separation of knower and known ("objectivity"). Feminism would be closely aligned with the world view underlying communion in that Feminism emphasizes wholeness and oneness, lack of separations, interdependence and interrelatedness, connectedness, cooperation (rather than mastery), and the inseparability of knower and known (the myth of objectivity). This is not to say that agency is totally rejected but that it is tempered and balanced with communion and restricted to situations in which it is appropriate, just as classical physics is not

totally rejected in the shift to modern physics.

Feminism, then, brings a radical transformation of the world view of patriarchy, of previous dichotomies (including feminine/masculine) and ways of perceiving, feeling, doing; the dissolution of linearity; and a critique of the compartmentalization and separations that have allowed us to interact with the world as Object (i.e., master it), with disastrous consequences for the entire planet. Feminism as a world view similar to that of modern physics focuses on interrelatedness, interdependence, and connectedness; on organic processes; on wholeness and oneness; and on the inseparability of knower and known.

Before proceeding to expand on this shift, it is necessary to articulate those aspects of Feminism that will not be explicitly included in the discussion of Feminism's parallels with modern physics. (These aspects are of course implicitly included by the very nature of those world views.)

They are:

1. Feminism challenges the patriarchal value of the male as the standard for human. It is pro-woman and values women as people, as human beings.

Perhaps it should be noted, because of our training in dualistic thinking, that being pro-woman does not mean being anti-man. The opposite of pro-woman is anti-woman, or woman-hating, well documented in books such as Figs (1970), Hays (1962), Millett (1970), and Daly (1978).

2. Feminism, in attempting to redress the internalization and institutionalization of patriarchal norms, means deliberate, conscious, and continual monitoring of the ways in which we all manifest and perpetuate anti-femaleness and anti-Feminism (for both women and men), including but not limited to biases/oppressions regarding race, class, lesbians/gays, age, and physical disability.
3. Feminism provides support for women. At this period in herstory/history, women must consciously support each other. Sara Evan's concept of "free social space" (1979:219) is also relevant here.

Let me now turn to an expansion of those world-view aspects of Feminism which share the world view of modern physics.

1. & 2. Interrelatedness, Lack of Separations, Connectedness
(Note: "1" & "2" from page 11 are being discussed together.)

Feminism sees (i.e., envisions) the world as interdependent and interconnected and as a "complicated web of relations," to borrow a description from physics. It values seeing relationships, connections, and processes, and tries to redress the extreme compartmentalization of the Western patriarchal way of thinking, doing, feeling.

According to Robin Morgan, "The either/or dichotomy is inherently, classically patriarchal" (1977:15). Morgan abhors "that puerile insistence on compartmentalization (art versus science, intelligence versus passion, etc.)," and says that reason without emotion is fascistic and emotion without reason is sentimental (1977:15).

The catchword of the Women's Movement, "the personal is political" and "the political is personal," sums up a perception of the error of previous dichotomies of reason/emotion, rational/intuitive, public/private, and fact/value as arbitrary categories that are not really separable. According to Morgan, it is "the insistence on the connections, the demand for synthesis" that is so much a part of what she calls metaphysical feminism (1977:16). And Daly: "...everything is connected with everything else: (1978:11).

3. Wholeness and Oneness

Feminism sees the oneness and wholeness of the universe. Though this is implicit in the first dimensions (1 & 2 above), it adds the concept that the whole is greater than the sum of its parts and is inseparable from the parts.¹¹ Compartmentalization, though sometimes necessary for living in our three-dimensional world, or what LeShan (1975) would term "sensory reality" is an idealization, not "reality," whatever that may be. Morgan talks about "the inclusiveness of the feminist vision, the balance, the gestalt, the refusal to settle for part of a completeness...." (1977:16).

4. Dynamic and Organic

Change and transformation are fundamental processes of any living system (Pelletier 1978:6). Feminism shares this belief and sees the world as a dynamic, not static one, as a living system. Feminists talk of

"relationships at the center of things" (Wetzel 1979:6), and see "structures of relations in process--a reality constantly in evolution" (Hartsock 1975:73). The world is continually growing, evolving, changing; and "we are in process, continually evolving" (Morgan 1977:14), "a process of integration and transformation" (Daly 1973:27). Morgan talks of this process as "an upward spiral, so that each time we reevaluate a position or place we've been before, we do so from a new perspective. We are in process...." (1977:14).

In contrast to the patriarchal-masculine-agentic focus on ends, process is a central concern and priority. As Morgan states, "the process, the form of change itself is everything, the means and the goals justifying each other" (1977:5). And Hartsock, "At bottom, feminism is a mode of analysis, a method of approaching life and politics" (1975:71).

Even Feminism itself, as a movement, is seen as "the dialectical expression of personal drama" (Morgan 1977:300).

5. Transcendence of Either-Or Categories

The criticism of patriarchal dualistic thinking is one of the most consistent and pervasive dimensions of Feminist writing, e.g. Morgan (1977), Rich (1979), Schaef (1978), Bunch (1976), Daly (1978). This dimension, the transcendence of either-or thinking, has been covered above so will not be repeated here.

6. Observer Inseparable from Observed, Knower from Known

A Feminist sees herself/himself as constructing, rather than discovering, her/his world. Yet, theory is "never neutral" and "cannot be separated from practice" (De Oliveira and Calame 1974:66), from experience. (The physicists' term "participator" is relevant here.) One's world view is a function of the interaction of one's biology, genetic makeup, and experiences; and objectivity is a myth.¹² The Feminist's struggle with the biases and distortions of patriarchy have helped bring the recognition that no one's view of the world, including one's own, is "objective" in the common sense connotation of "without bias,"¹³ and s/he recognizes that objectivity is not possible. But in this the Feminist is not really much different from anyone else--the

critical difference is that a Feminist acknowledges s/he is not objective.¹⁴

7. Relativity of Time and Illusion of Linearity

The concept in Feminism that seems closely related to some in modern physics is that linearity and direct cause and effect relationships are questioned. Anne Wilson Schaef describes a White Male System (similar to what I've labelled patriarchy), and a Female System (similar to what I call Feminism). In the White Male System, there is "a belief in the reality of numbers" (1978:12) and "time is believed to be its numbers. Time is believed to be what the clock measures" (1978:12). In the Female System, "time is seen as a process...one goes through cycles, rhythms, procedures, etc., and that it may or may not have anything to do with the clock" (1978:12).

Similarly, Mary Daly speaks of "the linear, measured-out, quantitative time of the patriarchal system" and of "women...living in a qualitative, organic time...in which events are more significant than clocks" (1973:43). She describes this movement as not linear "but rather resembles spiraling...." (1978:23). The spiral image is also used in Kollias' description of processes of change in the Women's Movement (1974:5) and by Morgan who talks about growth as "an upward spiral" (1977:14), as previously mentioned (p.15).¹⁵

In sum, Feminism provides the basis for a world view dramatically different from that of patriarchy. Whereas the latter emphasizes separations and divisions, fragmentation and independent parts, the separability of the self from the world, and static and mechanistic processes, Feminism emphasizes interrelatedness and lack of separations, wholeness and oneness, and inseparability of the self from the world and dynamic and organic processes. Thus, Feminism shares a world view strikingly similar to that of modern physics and patriarchy shares one strikingly similar to that of classical physics (see chart, p. 2), and both Feminism and modern physics are radical shifts from previous world views.

What, then, are the implications for teaching/learning in higher education?

IMPLICATIONS FOR TEACHING/LEARNING IN HIGHER EDUCATION

Both modern physics and Feminism are futuristic world views, fundamentally different from contemporary dominant ones. As such, both challenge society's basic beliefs, value systems, and structures, including higher education's. The discussion which follows focuses on the implications for teaching and learning in colleges and universities. Other areas, for example, research, are not included in order to limit the length of the paper.

The implications described below can be seen to flow from the world views of both modern physics and Feminism (though--note again--this world view is not common to all persons who call themselves Feminist). However, I have drawn primarily on my background in Feminism since this is the area in which I have spent the most time thinking about educational issues.

1. & 2. Interrelatedness, Interconnectedness, and Interdependence

If one views the world as interrelated, interconnected, and interdependent, then there are a number of implications for education. Four that seem important are:

- A. A continual and pervasive emphasis on interdependence, interrelatedness, and interconnectedness of people, nations, and the planet as well as processes of change and development. For example, a course on the psychology of adults must consider the connections of one's psychological change and development to the historical and social conditions of one's time as well as implications for the nation and planet of alternative images of the "healthy" adult. (See also discussion of interdisciplinary perspective in #3 below.)
- B. A linking of education to experience, experience being a "fundamental base for knowledge" (Hartsock 1975:78). This is represented in the Feminist insistence on connecting the personal and the political. For an instructor, this means facilitating insights into the interrelationships among personal experiences and the socio-political-historical structures. If one can see how one's own experience connects, the ability to see other connections is greatly enhanced.

- C. A linking of theory to practice and vice versa.
- D. An attention to process (the learning situation) as inseparably related to product (learning outcome). One does not, for example, "teach" democracy with authoritarian methods.

3. Wholeness and Oneness

A perspective on wholeness includes a transcendence (not just an integration, in the sense of combining separable parts) of dichotomies and of views of the world as discrete, separate, and indispensable parts, for dichotomies and categories are conceptual tools which do not exist separately either in human beings or in a wholistic universe.

For education this means redressing the extreme compartmentalization of knowledge (or subject matter). For the curriculum this means an acknowledgement of the arbitrariness of dividing knowledge/universe into categories, and a struggle to see things whole, a struggle for an interdisciplinary perspective, one that sees particular subjects and problems not in an isolated context but as intricately interrelated with a larger picture.¹⁶ Most liberal arts programs have this as an aim but they end up presenting multi-disciplinary rather than interdisciplinary views to students, for students are required to take courses in disciplines which remain discrete and unrelated to each other. Faculty have been trained in disciplines and find it difficult to move to an interdisciplinary approach.

In addition, education needs to redress the extreme compartmentalization and restriction of thinking processes to the rational domain and the repression of the intuitive. For the learning process, this means acknowledgement of the extreme emphasis placed on rationality in education and balancing this by facilitating intuitive ways of knowing as well as giving attention to affective processes in the learning situation. For women and other groups who have been allowed to be more intuitive (this may not be true of students in certain disciplines), this is a validation of themselves.

4. Dynamic and Organic

The educator needs to see both students and knowledge as continually evolving, growing, developing. Knowledge and the universe needs to be

seen as continually developing rather than capturable in bits and pieces of "information" and "facts" (building blocks?) which are better seen as working hypotheses. Daly's argument that we must change the nouns of knowledge to verbs of know-ing (1978:11) illustrates the way even language reflects static or dynamic concepts.

Hence, with students seen as continually developing,¹⁷ as beings in process, becoming, and with knowledge seen similarly, the instructor's role needs to include facilitation of the personal growth of the student as well as of the student's knowledge and conceptual base, including the skills required for continued learning. There is no end point to development.

The instructor as co-learner attempts to provide conditions for the development of autonomous life-long learners capable of taking responsibility for, and caring for, themselves and their planet. In contrast, education which is based on what Freire (1973) would call banking education is a contradiction to this. Such education attempts to fill students with knowledge and right answers (building blocks again?) possessed by the teacher/banker, thus subverting autonomy and responsibility by this process.

5. Transcendence of Either/Or

In addition to what has been suggested above, what would be useful in moving beyond either/or conceptualizations are (a) an explicit emphasis on categories as conceptual tools, not as reality itself ("the map is not the territory"); (b) a struggle to see the biases inherent in present categories (homosexual/heterosexual is a good example); (c) presentation in the classroom of multiple interpretations of whatever topic is under consideration, and (d) continually asking, "Is there another way to look at that," and "does it have to be either/or?"

6. Inseparability of Observer and Observed

The inseparability of observer and observed or knower and known means that an instructor must be in touch with what her or his own world view is, make this explicit to students, and continually try to stay in touch with his or her world view as it changes. In addition, the instructor

needs to assist students in recognizing the explicit and implicit world views which underly the material they read (e.g., biases of theories) as well as to assist them in recognizing the fluidity of the categories "value" and "fact." In doing these things, s/he is not involved in presenting The Truth to students but is sharing her/his own evolving "truths," and is facilitating students in their own searches.

The question that should be continually raised is, "How would that be viewed by someone with a different world view?"

7. Relativity of Time and Illusion of Linearity

If time is seen as a process and this is distinguished from clock time (Schaefer 1978, Daly 1973), then most contemporary education--predominantly based on clock time--is a denial of process time, that is, it does not allow for the fact that some people need longer periods of time for their learning processes.

The challenge to linear, direct cause and effect relations also has implications for education. Direct cause and effect seems most similar to S-R learning theory, and challenging the absoluteness of this view allows learning to also be seen in terms of a more complicated process of inter-actions and as a spiral rather than a linear pattern of development.

In sum, a shift to the world views underlying modern physics and Feminism would have a number of implications for teaching/learning in higher education. Changes would include an interdisciplinary perspective and approach, a linking of education to experience, a perspective on both students and knowledge as continually in process and evolving, a balance of rational and intuitive ways of knowing, an acknowledgement of the limits of objectivity and an articulation of one's own particular world view to students, and a continual emphasis on the interconnectedness and interdependence of people and the planet as a whole.

CONCLUDING COMMENTS

This paper has described the radical shifts in world view that have taken place from classical physics to modern physics and from patriarchy to Feminism, and has discussed some implications for teaching/learning in higher education.

I will not summarize here, since I have done so at the end of each section above. However, I do want to make some concluding comments.

As educators concerned about the future, it is critical that we be able to help ourselves and others, including students, diagnose the possible sources of present conditions and problems (described earlier) so that we do not continue to merely treat symptoms and apply technical solutions (e.g., see Henderson, Jan./Feb. 1975) and so that we can struggle to envision sane and healthy alternatives.

It is my belief that the world views we hold are critical contributors to our actions and interactions, to the problems we see, and that the world views of both patriarchy and classical physics exert a strong^{detrimental} influence on all our endeavors. The world views underlying modern physics and Feminism provide the basis for radically altering the dominant atomistic and reductionistic stance toward ourselves, other human beings, and the planet as a whole. Both provide the philosophical basis for a wholistic world view that is potentially more humane, just, compassionate, care-full, and responsible (able to respond). I would like to close by sharing with you one of my favorite quotations, Einstein's thoughts on the task before us:

A human being is a part of the whole, called by us the "Universe," a part limited in time and space. He experiences himself, his thoughts and feelings as something separated from the rest--a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty. Nobody is able to achieve this completely, but the striving for such achievement is in itself a part of the liberation and a foundation for inner security.

--Albert Einstein
New York Post, November 28, 1972

DEFINITIONS

The terms listed below are defined on the basis of how they are used in this paper and, where relevant, the context is American.

Agency

An approach to the world which is based on assertion, mastery, self-protection, isolation, alientation, and formation of separations. Developed by David Bakan (1966). Agency is contrasted with communion. (See "communion" below and footnote #10, p. 25.)

Classical Physics

Newtonian physics. Physics which is based on a mechanistic and compartmentalized view of the universe. (See "modern physics" below.)

Communion

An approach to the world which is based on a sense of being at one with other organisms, a lack of separations, an openness, and non-contractual cooperation. Developed by David Bakan (1966). Communion is contrasted with agency. (See "agency" above and footnote #10, p. 25.)

Feminist

A person who is pro-woman, is aware of the ways in which women, and to some extent men, are oppressed by sex-biased beliefs and institutionalized practices; and wants to move from a patriarchal society to a more egalitarian one. In addition, Feminists have a world view which sees the world as interrelated, whole, and dynamic and organic; are concerned with cooperation (rather than mastery) and with means and processes as well as ends; and strive to transcend culturally imposed definitions of feminine and masculine.

Note: Feminists differ along a number of dimensions, and while most Feminists would agree with the first sentence, the second one would be less commonly shared for it implies the need for changes more fundamental than equality of women with men.

Feminine

An adjective used to describe a person with characteristics such as dependence, non-rationality, intuitive, emotionally expressive, reserved and lady-like, non-assertive, timid, receptive, and concerned with relations (as opposed to tasks). Usually ascribed to females, but is culturally based and changeable and needs to be distinguished from the categories "female" and "woman" which are biologically based (genetic, gonadal, and hormonal criteria used) and unchangeable.

Higher Education

Education in two and four-year colleges and universities. (In addition, the education discussed in the paper is primarily formal and classroom.)

Masculine

An adjective used to describe a person with characteristics such as independence, rationality, emotionally inexpressive, aggressive, courageous, and dominant. Usually ascribed to males, but is culturally based and changeable and needs to be distinguished from the categories "male" and "man" which are biologically based (genetic, gonadal, and hormonal criteria used) and unchangeable.

Modern Physics

The relativity theory of Einstein and the quantum theory of Planck. Physics which is based on an organic and wholistic view of the universe. (See "classical physics" above and footnote #5, p. 24.)

Patriarchy

Commonly referred to as rule by one sex, the father, the patriarch, the male, and includes the consequent biases and institutionalized discrimination against women. In this paper it also includes the view of the world which emphasizes compartmentalization, separations and divisions, rationality, quantification, mechanistic processes, prediction and control (mastery), and a focus on ends rather than means and processes.

FOOTNOTES

- ¹ Society is used in the larger sense of culture in general, not merely societal organization. I did not use the word culture because of its frequent use to mean arts and sciences rather than the network of beliefs, practices, etc., that comprise a culture.
- ² The reference to "planet" rather than merely "society" or other more localized term is used in the belief, similar to Keys' (Planetary Citizens..., 1978:24), that it is critical that our concern include the planet rather than be restricted to a narrow focus on one's own life, locale, or nation. This is, in my mind, not only a pragmatic necessity if we are to survive on an interdependent planet but a moral and ethical imperative for care and concern about all life. I also realize I could have included "universe" here rather than "planet" but I have little conception of how we affect the universe (including past, present, and future in this category).
- ³ Conversation with Art Harkins, futurist, University of Minnesota, October 11, 1979.
- ⁴ "Non" here means "not only" rather than "not at all."
- ⁵ Some of Einstein's theories retain elements of classical concepts, for example, the one-to-one correspondence with reality. But for purposes of this paper it is not necessary to delve into these differences and I have included him in the modern physics world view. See Zukav (1979:25) for discussion of the classical elements in Einstein's theories.
- ⁶ It should be noted that Newton's laws are based on observation of the everyday world and predict events. Quantum mechanics is based upon experiments conducted in the subatomic realm. It predicts probabilities pertaining to subatomic particles and these particles cannot be observed directly (Zukav 1979:46).
- ⁷ These "probability waves" are "abstract mathematical quantities related to the probabilities of finding the particles at particular points in space and at particular times" (Capra 1977:22).
- ⁸ See also discussion of Bohm's concept of the enfolding and unfolding universe and the implicate and explicate order in Re-Vision (1978). This issue also includes discussion of neurophysiologist Pribram's concept of the holographic brain and the holographic universe.
- ⁹ Capra explains that particles can:
 "no longer be pictured as static three-dimensional objects...but must be conceived as four-dimensional entities in space-time. Their forms have to be understood dynamically, as forms in space and time. Subatomic particles are dynamic patterns which have a space aspect and a time aspect. Their space aspect makes them appear as objects with a certain mass, their time aspect as processes involving the equivalent energy.

(continued)

⁹ (continued)

Relativity theory thus gives the constituents of matter an intrinsically dynamic aspect. It shows that the existence of matter and its activity cannot be separated. They are but different aspects of the four-dimensional space-time reality" (Capra 1976).

- ¹⁰ Although Bakan says agency is more characteristic of males and communion of females, in his discussion of agency and communion in his book he has included more of the negative aspects of masculinity and less of the negative aspects of femininity. So in terms of the perspective I am presenting, his description is closer to Feminism than to stereotypic femininity; and the agency/communion distinction seems to provide a parallel to the distinction in world view between classical physics/modern physics.
- ¹¹ For scientific views of this concept, see Re-Vision (1978) and Pribam (1979). In these publications, physicist Bohm and neurophysiologist Pribam discuss their intriguing theories of the hologram as a metaphor for the universe. See also Leonard's, The Silent Pulse (1978).
- ¹² Most people are aware of cultural influences on one's perception of the world but may not be aware of biological factors. I do not mean genetic only. I do mean biological makeup in a very fundamental sense. For example, our eyes are a lens on the world and we can ask the question, "How would we 'see' the world if the sense receptors in our eyes had been constructed differently, e.g., X-ray vision or microscopic vision?"
- ¹³ In an earlier edition of this paper, I distinguished here the usage that means "publically verifiable" but the more I think about it, this has its own set of problematic assumptions.
- ¹⁴ I realize that this is not true of all Feminists, but I believe the statement is accurate as a generalization in that as I listen to research papers at conferences it is Feminists who feel compelled to state that their work is not objective and value free.
- ¹⁵ It seems that the spiral is becoming the metaphor for growth by Feminists as well as others. Human growth and development as represented by a spiral rather than a linear line is also an image that has developed in cognitive-developmental psychology. Interestingly, Bateson in his new book Mind and Nature, says, "...all spirals in this world, except whirlpools, galaxies, and spiral winds, are indeed made by living things" (1979:106).
- ¹⁶ The very language we use is important to consider. For example, when I first wrote this I said "but as part of a larger whole." This became "but as intricately interrelated with a larger whole." This difference here is as significant as that between classical and modern physics conceptions of the world.
- ¹⁷ This conception of the human being has much in common with the psychological theories and research of people like Kohlberg (1978) and Perry (1970). Discussion of these theories as well as their limitations (see Scharf, 1978, and Koplowitz, n.d.) is beyond the purpose of this paper.

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